Protecting Public Values under Tradable Water Permit Systems:

Economic Efficiency and Equity Considerations

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I. Water Institutions and Economic Inefficiency in the Allocation of Water.

The focus of this paper will be on issues of economic efficiency and the fairness of water allocation mechanisms in regions that have adopted the appropriations doctrine. These are typically semi-arid regions where irrigated agriculture accounts for a large part of consumptive use. As urban areas, industry and (especially) recreational and environmental uses of water expand, the reallocation of existing supplies of water becomes a major issue. Indeed, in light of the high economic and environmental costs of developing new water supplies, reallocation becomes a necessary condition for economic development (Howe, 1978).

The concept of economic efficiency refers to an allocation of (scarce) resources in a way that maximizes the measurable value of useful products and services as measured by market prices or corrected market prices and by techniques that allow non-marketed services to be valued in monetary terms. At the economy-wide level, this would be manifested roughly in the value of the "gross domestic product" (consumption goods and services, investment goods and services, government uses of goods and services, and net exports) augmented by the monetary value of non-marketed services of natural resources and the physical environment (e.g. non-marketed recreation, biodiversity, aesthetics, improvements in health from a cleaner environment) insofar as these can credibly be given monetary values. At a regional or river basin level, the corresponding measure would be the "regional gross domestic product". At the individual project level, economic efficiency is reflected in correctly calculated "benefit-cost analyses" that include both marketed and non-marketed outputs and costs. There is today, a broad consensus among economists concerning the methods that should be used in making these measurements, although there remains some argument concerning how far non-market valuation can be extended (see Mitchell and Carson, 1989). Some advocate a multiple-criteria approach in which the more esoteric non-market services (e.g. biodiversity) are described and informally given weight in the decision process without assigning monetary values (see Cohon and Marks, 1974).

The concept of "fairness" or "equity" is, to a much greater extent, in the eyes of the beholder, but the distribution among groups of the benefits and costs generated by projects and management programs can usually be roughly estimated. This part of economic analysis is extremely important in forecasting public reactions to project or program proposals and in designing steps to mitigate negative impacts on disadvantaged groups.

As noted above, the ability to reallocate water in the face of changing conditions in a fair and economically advantageous way is an issue of overriding importance. Current institutions frequently inhibit this flexibility. Since markets , under the right circumstances, provide responsive ways of reallocating resources, water markets or systems of tradable water abstraction permits have been strongly advocated for many years (Hartman and

Seastone, 1970; Carter, Vaux and Scheuring, 1994; Anderson, 1983). Advocating water markets credibly, however, depends on exhibiting losses that are occurring as a result of lack of flexibility.

The economic costs of the inability to effect reallocations of existing water supplies have been the subject of several recent studies. Vaux and Howitt (1984) estimated for California that annual savings of $200 million could be achieved through interregional (north-south) reallocation of water from agriculture to urban areas. Booker and Young (1991) in their study of the allocation of Colorado River water between Upper and Lower Basins found that institutional inability to take into account the values created by non-consumptive uses (hydro-power, recreation and reduced salinity concentrations) results in too much water being consumed in the Upper Basin from an economic efficiency point of view.

Wahl (1994) described opportunities within California for highly beneficial reallocation- transfers that are inhibited by a state system of water law that mixes appropriations and riparian doctrines , by the importance of supplies from very large federal and state projects that tend to tie water to particular districts through contracts, and by the subsidies for irrigation water that hold excessive water in irrigation. Howe and Ahrens (1988) estimated opportunity costs incurred because of jurisdictional limits on the trading of water rights-opportunity costs in the form of downstream values lost because of upstream abstraction. For the Upper Colorado River basin, these opportunity costs ranged from $99 per acre-foot for the Green River sub-basin to $341 per acre-foot for the Upper Main Stem sub-basin.

Water-related “institutions” or, perhaps more appropriately, the “institutional framework” within which water-related decisions are made is intended in this paper to encompass the set of laws and regulations relating to water development and management as well as the agencies that have responsibilities for executing them. Strongly held customs and social practices are also part of this framework, for they cannot and should not be ignored in water planning and regulation. These components of the institutional framework are usually slow to change, especially in a democratic setting, since potential losers try to impede change or demand compensation. This in particularly true in the water policy arena(Ostrom, 1992; Mueller, 1979; Russell, 1979). As a result, laws, regulations and agency policies always lag behind the changing economic and demographic scene, resulting in patterns of water use that are no longer appropriate.

The resulting economic inefficiencies often offer opportunities for “win-win” resolution, i.e. situations in which a reallocation of resources could produce sufficient benefits that all losers could be fully compensated while leaving the winners better off than before. Such an opportunity for allocative improvement is called “ a Pareto improvement” in the jargon of economists. Unfortunately, it is often not practically possible to compensate all losers because of difficulties in identifying them or because the benefits are not in the form of government revenues that could be used for compensation. The desirability of the reallocation is then left up in the air because judging it to be either

desirable or undesirable involves a value-judgment about the relative importance the parties experiencing the gains and losses.

Thus, out-dated institutional arrangements are often the cause of inefficient allocations of our water resources, while our inability to compensate those who would lose from better allocations often stymies improved allocations. We have much to learn about institutions and appropriate compensatory schemes.

II. Strengths and Weaknesses of Current Water Allocation Mechanisms.

Water allocation arrangements evolve slowly from a particular historical situation. No one mechanism will be best for all settings. Nonetheless, because of the slowness of institutional adaptation, many regions find themselves saddled with inappropriate, inefficient water allocation mechanisms. It is worthwhile, therefore, to consider the characteristics one would like to see in an appropriate water allocation mechanism.

A. Criteria for Judging Water Allocation Mechanisms.

The large literatures on water administration and property rights suggest to this author the following set of criteria for evaluating water allocation mechanisms (e.g. Howe, Schurmeier and Shaw, 1986b; Tarlock, White and Keane in National Research Council, 1990; Howe/Goodman, Frohlich/Oppenheimer, Shabman/Cox, Saleth/Braden in Dinar and Loehman, 1995; Demsetz,1967; Milgrom and Roberts, 1992):

1. flexibility of water allocation over time in response to changing conditions;
2. security of tenure for water rights (permits) owners;
3. ability of water rights (permits) owners to adjust the riskiness of their water supplies;
4. broad agreement that the procedures are “fair” or “equitable” to most parties affected by the allocation or reallocation process;
5. ability to protect public values that are not included in the considerations of the direct participants in the allocation or reallocation process;
6. reflection to the water right(permit) owner of the full “opportunity cost” of the water being used;
7. low transaction and administrative costs.

These criteria are largely self-explanatory, but a few observations are warranted. The *flexibility* criterion stands in contrast to riparian doctrine, systems in which water is permanently attached to specific land parcels, or the allocation of water through contracts that prohibit or strongly inhibit water transfers. The latter is found in many Bureau of Reclamation contracts.

Security of tenure simply means that the right (permit) owner is assured of continued ownership until he/she decides to sell or otherwise transfer. It relates to the property right, not to the riskiness of the supply source. The *ability to adjust riskiness of the supply* is most easily illustrated in priority water rights systems under which one can buy either senior or junior rights. There are, of course, ways of dealing with the riskiness of supply in non-priority systems. In "proportional" systems (wherein available water is divided among users in proportion to the number to the number of shares or permits held), the water user can buy more shares than will be needed on average to hedge against low supplies - at least to the extent allowed by the "beneficial use" doctrine. Cities of the western U.S. continually hold excess water rights and shares in mutual companies to guard against shortages, as well as developing "conditional rights" against future growth of demand. Another common device is to acquire water rights in several different drainages of differing climatalogical and hydrological characteristics to reduce dependence on only one supply regime.

The *fairness criterion* to parties affected by water allocation or reallocation is difficult to define in a way that can cover all cases. When there are free market type transfers, the buyer and seller are clearly made better off (assuming no fraud is perpetrated) but third parties frequently perceive themselves to be worse off for economic and environmental reasons. This issue will be discussed in some detail later in this paper, but it raises the broad and seldom treated issue of gainers compensating losers, however the latter are defined.

We will discuss at length *public values* that are likely to be slighted in market transfer processes. These problems usually occur because of jurisdictional differences or because water quality management is not synchronized with water quantity management. Upstream parties frequently consume and contaminate rivers with no liability for the negative downstream effects. This issue overlaps with that of *making water users aware of the full "opportunity costs" of the water they are using.* When there are no water markets, the "beneficial use doctrine" motivates water users to ignore these opportunity costs.

Low transaction costs speak for themselves. They consist of all costs of *search, legal and engineering studies, court or public agency charges, as well as those costs incurred by public agencies.* High transaction costs can quickly offset gains from trade. These costs are affected by the type of administrative system in use, e.g. Colorado's water court system *versus* New Mexico's reliance on the Office of the State Engineer to oversee water allocation and water transfers. They are also affected by the information systems

that bring buyers and sellers together. In Colorado, "water brokers" help identify potential sales of water rights or shares in water districts or ditch companies (see Howe, Schurmeier and Shaw, 1986). In the Westlands Irrigation District in the San Juaquin Valley of California, farmers are using a computer network to identify potential short-term water trades during the irrigation season (get Howitt reference).

B. Classes of Water Allocation Mechanisms.

Many variants of water allocation/re-allocation mechanisms exist around the world, from the Spanish water auctions of ancient origin (Maass and Anderson, 1978) to computerized trading in the Westlands District. We confine our taxonomy to systems that are currently found in the United States. While one can argue about the descriptions of the various classes, this grouping allows a preliminary comparison of the pro's and con's of major systems using the criteria listed above.

1. Administrative systems that issue non-tradable abstraction permits or rights.
   Examples: Hawaii (Moncur, 1989) and various eastern U.S. states (Sherk, 1985).
2. Administrative systems that issue tradable abstraction permits or rights.
   Example: earlier Hawaii system (Moncur, 1989).
3. Systems based on riparian doctrine.
   Examples: many eastern U.S. states (National Water Commission, 1973).
4. Systems based on appropriations doctrine.
   Examples: most western U.S. states.
5. Public and private supply projects that convert underlying water rights to contract deliveries, usually in proportion to the shares owned. Examples: Bureau of Reclamation projects, mutual irrigation companies, etc. These contracts are frequently not tradable or restricted to trades within the same project or district.

Of these five, 2 and 4 can be called "market systems" while the institutions in 5 may rely on markets for the distribution of shares. An example of the latter would be the Northern Colorado Water Conservancy District (Howe, 1986; Michelson, 1994).

C. Evaluation of the Allocation Mechanisms.

The *administrative issuance of non-tradable permits* fails the flexibility criterion and may well fail the security of tenure criterion if continuation of permits is a matter of administrative discretion. An example is found in the Southeastern Colorado Water Conservancy District in which the committee allocates water from the Fryingpan-Arkansas Project each year. The ability of water users to adjust the supply risks they face depends

entirely on the limits the agency puts on the amount of water it is willing to allocate. Assuming that all permits share proportionally in the water available, the more permits issued, the less reliable each permit will be. While New Mexico is an appropriations state, the State Engineer closes new appropriations on a stream when all "reliable" water has been claimed. If reliability is high (e.g. appropriations are stopped at the 80th percentile flow), then all appropriators will enjoy a high level of reliability. If, on the other hand, the water agency is constrained as it would be in Colorado where "the right to appropriate cannot be denied", the more permits issued, the less reliable all permits will be.

Such a system may be perceived by the public as fair as far as it perpetuates a stable pattern of water use, but it may be quite unfair to prospective buyers and sellers by denying them the possibility of selling the permit or right. In many agricultural communities, farmers' greatest source of wealth lies in their portfolio of water rights that could have high values in the presence of a market. Whether or not the system is sensitive to public values depends very much on the horizons of the administrative agency. Given the tendency of many public agencies to serve a narrow clientele, there is no guarantee that such systems will perform well in this regard. There will be no reflection of "opportunity cost" unless the permits are of limited duration with the agency reallocating in new patterns that track social and economic changes. Administrative costs depend on the same set of issues, i.e. the extent of investigation (or litigation) that is required at the time of re-issuance.

Administrative issuance of *tradable permits* has much to commend it. Tradability provides the flexibility needed for efficiency. Security of tenure, of course, depends on the terms of the permits: their duration and the powers of revocation by the agency. The question of the risk facing water users depends on the limitations placed on the number of permits by the agency. Fairness, as usual, depends on the transparency of the procedures followed by the agency, while the representation of public values depends on the breadth of the agency's perview. In contrast to the issuance of non-tradable permits, the existence of a market continually presents the water user with some measure of the opportunity cost of the water being used. We use the term "some measure" because the price of permits will depend on the geographical extent of the market: if all affected parties can participate in the market, then the price of permits will reflect the full opportunity cost of the water. If the extent of the market is limited by jurisdictional boundaries, then market prices of permits will reflect only "local" opportunity costs. Transaction costs can be quite low if litigation is avoided. (footnote here. Thanks to David Getches for pointing out the potential benefits of this type system.)

Systems based on *riparian doctrine* are really inappropriate when there are non-riparian demands for water and when streams become "fully appropriated", i.e. when all reliable supplies are already in use, so that any additional use interferes with existing uses. Riparian doctrine lacks the flexibility of transferring water to non-riparian users who will be, in many situations, the highest-value users. It provides security of tenure, subject to the possibility of litigation to enforce "reasonable use", a term whose meaning changes with time. (footnote here. David Getches has pointed out that the reasonableness standard

is embraced in determining liability in millions of automobile accidents each year-based on the law of negligence.) Risk adjustment is difficult because all users are equally subject to the vagaries of hydrology, while new users who qualify for abstractions change the flow and quality characteristics to some extent, even when the new uses are "reasonable". "Fairness" is in the eyes of the beholder, so that existing riparians probably see the system as "fair" while those who would put the water to other non-riparian uses must question the fairness of the system. (Question here re protection of public values: which parties have standing to protect instream flow uses, e.g. for recreation, aquatic habitats?) The reflection of opportunity costs of the water being used is nullified by the absence of tradability. While tradability could be initiated among riparians, the trading orbit might still exclude higher valued uses. Naturally, riparian *sites* can be traded, but this is, in general, a very inefficient way of reallocating water. Regarding transaction costs, the costs of litigation must increase nonlinearly as demand for riparian uses increases.

The advantages of *appropriations doctrine* have been alluded to several times. Such systems have provided flexibility of allocation in the western United States for 100 years. Water markets are active within each western state. While these markets may lack some of the characteristics of purely competitive markets (e.g. the extent of the market and thus the number of potential participants may be limited by the ability to move or exchange water), they have served to reallocate water under changing conditions. The studies by MacDonnell et al (1990) have shown the high levels of activity in six western states, especially in Colorado, New Mexico and Utah. Security of tenure is subject only to standards of "beneficial use" which have been interpreted in a very lax manner by state water agencies and courts. Since these are priority systems, by definition, they provide the ability to adjust risk levels. "Fairness" is guaranteed to the buyers and sellers almost by definition, but the "third party" impacts are frequently seen as unfair by those indirectly affected by transfers (a topic to be expanded later in this paper).

Through the creation of markets, appropriations systems present the water owner with the opportunity cost as determined in the relevant market. The difficulty is that the extent of the market may be severely limited by jurisdictional boundaries, e.g. the failure of Upper Colorado River Basin water values to reflect the values of water in the Lower Basin, or, indeed, the failure within a given drainage to reflect values not represented by traditional water rights such as recreation, riparian habitat, or hydro-power values. The protection of public values also poses a serious problem when the values are not recognized as "beneficial use" as was the case for many decades with all instream uses.

Transactions costs under appropriations doctrine depend very much on the method of administration and the rules followed in allowing claims for water rights. The contrast between the Colorado water court system and the state engineer systems of New Mexico and Utah stands out (Hartman and Seastone, 1970) in this regard. The state engineer offices provide the unbiased expertise needed to evaluate proposed transfers (e.g. for third party damages and extent of consumptive use). Their estimates are accepted by all parties most of the time. Under the Colorado water court system, the proposed seller and buyer must make their case to the court in the face of opposition from third parties who perceive

themselves to be potentially injured. Formal objections to transfers are frequently automatically entered by large water users, especially cities, to provide the opportunity to study the effects of the transfer. Thus much effort if duplicated, while buyers/sellers and third parties are motivated to bias their analyses in favor of their objective.

Transactions costs also depend on the rules established for water appropriation, either by the administrative agency or in the state's constitution. In Colorado, the constitution provides that "the right to appropriate water shall not be denied", so that most streams become "over appropriated", i.e. have more water rights outstanding than there is reasonably reliable water. Then, almost any proposed transfer will injure some other party and opposition and court hearings are nearly guaranteed. In New Mexico, the State Engineer closes appropriations on a stream when all "reliable" water (perhaps the 80th percentile flow, i.e. the flow that is present or exceeded 80% of the time) has been claimed . This means that the streams seldom need to be "administered"(i.e. shutting off junior rights) and that proposed transfers are much less likely to have adverse effects on other water rights.

Large public or private water storage and distribution projects generally develop a natural water source for which water rights must be claimed and validated. The developed water supply is then usually allocated to customers through contracts. This usually results in an allocation of available supplies in *proportion* to the number of shares owned or amounts under contract, with all participants sharing equal proportional risks. In many cases, the contracts tie the water supply to particular uses or to use within the administering district. Over time, these restrictions lead to increasingly inefficient patterns of use as social and economic demands change (e.g. see Gray, 1989, for descriptions of contractual arrangements in California). However, efficient markets can develop *within* districts. A prime example is the Northern Colorado Water Conservancy District that covers a large part of northeastern Colorado and that distributes water from the federal Colorado-Big Thompson Project (Howe et al, 1986a). This District has a large market area and, through natural rivers and a complex system of canals, can physically transfer water to and from almost any point in the District. The Colorado legislation establishing conservancy districts permits the water to be supplied to any "beneficial use", including industrial and urban uses, so that there has been a smooth transfer of water from agriculture to M&I uses. Instream flows, however, have no specific protection, although the Project has increased flows in most parts of the system since 270,000 acre-feet is imported each year on the average.

Thus, markets can be developed in various ways, the overall efficiency depending on the extent of the geographical area served (larger is better) and the rules imposed . Whatever the mechanism chosen for water allocation in particular states, it is clear that water markets will play an increasing role in the majority of systems.

III. Public Values That Are Inadequately Protected Under Water Market Systems.

Largely because of unprotected public values, the public of the western United States has shown increasing resistance to water marketing and, in particular, to market-generated interbasin transfers of water. In Colorado, legislation has been introduced in the past several legislative sessions to prohibit or severely constrain out-of-basin transfers (for some of the history of this issue, see MacDonnell and Howe, 1986). It will be worthwhile, therefore, to identify those public values, to determine the extent to which they should be protected, and to explore ways in which this protection might be efficiently provided under a water market system.

A. Uncompensated Ordinary External Costs.

In all water systems, there remain uncompensated economic externalities. These refer to physical impacts on other parties caused by a water user's actions. While these impacts can be either positive (beneficial) or negative , they are most often negative in nature. A prime example would be the increase in downstream salinity caused by upstream consumptive use. Most water diverters are not required to take into account the deterioration in water quality they impose on the stream. Upstream irrigators increase salinity concentrations for downstream irrigators, negatively affecting crop yields. Skogerboe and Walker (1972) and Leathers (1975) estimated that the Grand Valley Irrigation Project of western Colorado was contributing 10 (short) tons of salt to the Colorado River per irrigated acre per year. This huge addition of salt occurs just before the River flows into the State of Utah and hence downstream to the Lower Basin. Neither the Colorado River Compact nor the Upper Basin Compact, nor any legislation limits this pollution nor in any way holds the contributing District responsible for the resultant damages to irrigators and M&I users downstream. Similarly, parties who propose to export headwaters water often are not required to take into account the reduced flows and increased concentrations of dissolved solids occasioned by their use.

If one were optimizing water use patterns across an entire river system, all of these impacts would be taken into account. In real life, jurisdictional boundaries often preclude these considerations. Howe and Ahrens (1988) have shown that the consumptive use of one acre-foot of water in the Upper Basin of the Colorado River precludes downstream values ranging from $99 to $341 (1988 dollars). Since agriculture is the largest consumer in the Upper Basin and since marginal agricultural values of irrigation water lie in the $35 per acre-foot range (Booker and Young, 1991), present water use patterns in the Upper Basin impose large net losses on the Colorado River system. These patterns continue not because anything illegal is being done but because the institutional framework for water administration is broken into Upper Basin/Lower Basin, state-by-state areas, each

assigned allowable uses under existing compacts and state laws. The resulting patterns of water use are, in a historical context, fair, but they remain very inefficient. In terms of water markets, the extent of the markets is not great enough to allow the markets to reflect total system water values. Colorado water courts have been reluctant to apply the no injury rule even to instream values within the State, while the Colorado River Compact absolves Upper Basin users from liability for lost Lower Basin values.

We will later discuss ways of overcoming these externalities, i.e. ways of motivating water rights owners to take them into account. One way would be to extend the geographical scope of water markets so that all values are reflected in the market prices of water rights.

B. The Problem of "Public Good" Values Generated by Water Systems.

Many of the externalities mentioned above involve diminished benefits of a type that have two unique characteristics: (1) the benefits are of a type that can be enjoyed by many people without diminishing the quality of the benefit; and (2) it is impossible or impractical to require people to pay for the benefit. An example of such a benefit would be an improvement in water quality that can be enjoyed by many instream recreationists, those who enjoy the improved water quality from the shore or adjacent lands, and even those who don't observe the stream but are satisfied to learn that conditions in the river have improved. If the stream passes through public lands to which the public at large has free access (e.g. the national forests and BLM lands), it may be impossible to isolate the stream in such a way that people can be forced to pay for the water quality improvement as a condition of access to the stream. Such a benefit or good is called a "public good" in economic jargon, not that it is necessarily publicly provided but that it shares the two characteristics described above.

The significance of public goods is that (1) they should be accessible to as many people as possible since one person's enjoyment doesn't diminish others' enjoyment and, thus by implication, (2) the economically efficient price for such a service should be zero, in turn implying that revenues won't be generated for the entity providing the good.

To a good approximation, improvements in instream conditions (flows, quality, timing) are public goods. It is difficult to for private business to provide or be concerned about such conditions since it is both difficult and undesirable to charge beneficiaries for the improvements. Should people be asked to pay for such improvements on a voluntary basis, they are likely to become "free riders" who reason that, since many people will be asked to contribute for the improvement, their decision not to pay will have no significant effect on the outcome.

For these reasons, public good values associated with instream flows are likely to be slighted by private water rights owners and even public agencies who cannot gain revenues from their provision.

C. The Problem of "Secondary Impacts" of Water Transfers.

The term "secondary impacts of water transfers" refers to changes in the levels of business experienced by those who supply inputs to or process the output of a business that is either the seller or the buyer in a water transfer. Since the majority of transfers are from agriculture to urban uses, the secondary impacts associated with the sale of water would consist of the reduced sales of inputs like seed, fertilizer, chemicals, and equipment and, on the other side, the reduced availability of agricultural outputs for further processing. The secondary impacts associated with the availability of a new supply of water for the buyer would, perhaps with some time lag, consist of similar positive impacts, i.e. a greater demand for inputs and a greater availability of outputs.

The usual economist's view of these impacts is that they are simply "the way the market works" to withdraw or supplement resources at the two ends of a water transfer. The typical economic conclusion is that secondary impacts should be ignored in analyzing water transfers since any real economic losses at the selling end are likely to be offset by real economic gains at the buying end. The timing of the gains and losses is typically ignored in this analysis, although in most water transfers, the losses occur when the water gets transferred while offsetting gains may be far in the future as cities or industry buy water in anticipation of future needs. Traditional economic analysis assumes that these flows of resources away from the point of sale and towards the point of purchase take place quickly and without cost to the parties involved.

The errors in such analysis are obvious if not easily quantified. Sale of water is most frequently from marginal, depressed agricultural areas. There is then likely to be long-term unemployment of human and other non-specialized resources (see Howe et al., 1990). From the point of view of economic efficiency, the idleness of resources that would have been employed in the absence of the transfer constitutes a real economic cost for the area of origin. Job search and moving costs are real. While these costs may be offset by similar gains at the point of water purchase, the costs and gains take place at different times and in different places.

Especially in the case of large water transfers, the negative secondary impacts in the area of origin are highly visible and attract public opposition to transfers. The absence of compensation and assistance exacerbates the malaise. An example is found in the Arkansas River Valley of Colorado in Crowley County, Colorado where the sale of 80,000 acre-feet of water from 40,000 acres of land under the Colorado Canal resulted in large-scale negative impacts, including an 80% drop in the County's tax base, bankrupting the County just at the time when increased social services were badly needed.

Data on historical transfers from the Arkansas River in Colorado illustrate the progressively more serious impacts of transfers on the area of origin. Early transfers were from nearby agriculture to the City of Pueblo or its suburbs. These transfers supported the growth of new industry in the same economic area from which the water had been transferred, leading to net gains for the regional economy. Employment and regional income data on the early transfers are exhibited in Table 1.

Table 1

Negative Impacts of Older Historical Transfers
from Irrigation to Municipal and Industrial Use:
Arkansas River, Colorado.[1]

Reductions in Employment:
total reduction = 157 jobs
1 job per 309 acres (124 ha.)

Reduction in Regional Net Income:
$5,290,000 per year
$44 per acre-foot of consumptive use.

Reduction in Local/State Government Revenues:
$506,350 per year
$4 per acre-foot of consumptive use.

Later transfers were larger and mostly to points out of the Arkansas River Valley economic area (Colorado Springs was an important purchaser. While still in the Arkansas drainage, its economic area is widely separated from the Arkansas Valley) with noticeably larger regional impacts as shown in Table 2.

[1] The historical transfers analyzed were (1971) Las Animas town Ditch to Pueblo West, 10,000 af; (1971) Highline Canal to Pueblo, 2,600 af; (1972) Booth-Orchard to Pueblo, 9,000 af; (1972) Holson Ditch to Pueblo, 1488 af. Total acre-feet = 23,088, total acres = 11,500.

Table 2

Negative Impacts of More Recent Transfers
from Irrigation to Municipal and Industrial Use:
Arkansas River, Colorado[2]

Reductions in Employment:
total reduction = 59 jobs
1 job per 275 acres

Reduction in Regional Net Income:
$6,740,200 per year
$207 per acre-foot of consumptive use

It seems likely that further large-scale water sales will take place and that their impacts on the Arkansas Valley will be more severe as superior acreages with higher valued crops linked directly to food processing are phased out. Estimates from our 1990 study are given in Table 3.

Table 3

Estimated Negative Impacts of Possible Future Transfers
from Irrigation to Municipal and Industrial Use:
Arkansas River, Colorado.[3]

Reductions in Employment:
total reduction = 1219 jobs
1 job per 106 acres

Reductions in Regional Net Income:
$131,760,320 per year
$408 per acre-foot of consumptive use

[2] The transfers included were (1974) Colorado Canal (Twin Lakes shares) to Pueblo, Colorado Springs and Aurora, 57,000 af; (1984) Las Animas Consolidated Extension to Public Service Company, 10,186 af; (1985) Colorado Canal to Colorado Springs, 43,180 af; (1990) Rocky Ford to Aurora, 18,770 af; (1986) Highline Canal to Aurora, 2250 af; (1991) Keesee Ditch, 3500 af. Total acre-feet = 134,900. Total acres = 67,400.

[3]The transfers projected on the basis of discussions with local water users and officials were (2001) Holbrook Mutual to Denver area, 24,438 af; (2004) Fort Lyon Canal to Denver area, 152,750 af; (2007) Amity Mutual 56,525 af; (2010) Bessemer Ditch to Denver area, 24,313 af; (2013) Catlin Ditch, 24,375 af. Total acre-feet = 282,400. Total acres = 112,960.

The point is that the negative impacts on the basin of origin increase non-linearly as transfers progress. While the selling farmers are presumably better off as a result of the sale, the community suffers serious losses during a long transition period.

D. Protecting Social and Cultural Values.

Many of the secondary impacts of water transfers can be quantified through the use of regional economic models, generating data of the type exhibited in the preceding section, e.g. regional income and employment changes, changes in local government revenues, sectorial changes in sales, etc. Many community values cannot be captured in quantitative terms but warrant consideration in decisions about water transfers. This is particularly true in traditional, low income communities in which water often plays an important symbolic, cultural value. In the southwestern United States, the old canal (acequia) systems not only support the local agricultural system but maintain social cohesion since maintenance of the canals and distribution of the water must be community efforts(reference here on the acequia systems). In village of San Luis, Colorado the annual cleaning and blessing of the canals is a major social event.

In these old systems, the water rights belong to the community, so that community-wide decisions have to be made if water is to be sold and transferred outside the community. While this appears to require a consensus on water sales outside the community, the low income levels and (seemingly) the high prices offered for water make such decisions difficult, requiring a tradeoff not only between the level of agricultural activities and alternatives made possible by the proceeds from water sales but between life styles and cultures.

This is not to argue that traditional societies should forever remain unchanged but that the “playing field” is quite uneven between low income traditional societies and the more advanced sectors. Maintenance of these cultures may be of concern not only to the traditional peoples but to the regional or even national populations-a set of values that calls for protecting the traditional uses of water. In an interesting case in the State of New Mexico (Sleeper vs. New Mexico, 1984), a state district court reversed the State Engineer’s approval of a transfer of acequia water to a ski area, on the grounds that the sale would unduly damage the culture of the community. Although this decision was reversed on appeal, it showed an institutional concern for traditional cultures that went beyond the economic tradeoffs open to the community and initiated a new dimension of concern in the evaluation of water transfers.

IV. How Should Public Values Be Protected?

Once it has been determined that there are important public values that are not adequately protected in water market transactions (or in other types of administrative actions), there is the issue of protecting the values *in an economically efficient manner*. We feel that water markets should continue to play a major role in the allocation of water, but the functioning of markets needs to be strengthened through institutional reform and constrained where it fails to account for important social values. Experience in western U.S. water policy analysis suggests that the following steps need serious consideration.

A. Mitigating Jurisdictional Externalities.

Many of the external costs imposed on other water users mentioned earlier stem from the existence of political sub-divisions that differ from the river basins being administered. Since water law in the United States is mostly a state matter and since the historical creation of water rights bore little relation to current values of water in various uses, the rules by which water is allocated are frequently quite myopic from a river basin point of view. Even the interstate compacts that divide water among states are outdated from an economic point of view because of differential growth rates of upper basin and lower basin economies and demographics.

One way of mitigating the inefficiencies of allocation at sub-state, state and interstate levels would be to establish river basin authorities or commissions with the power to consider the entire river basin in the planning process. This was, in fact, attempted in the Water Resources Planning Act of 1965 which authorized the establishment of river basin commissions for planning and management purposes. Eight (?) commissions were subsequently established (New England, Great Lakes, Ohio, Upper Mississippi, ...). Each commission was overseen by a board comprised of a member from each riparian state, plus a member from the Corps of Engineers and, in the West, the Bureau of Reclamation. Decisions were by unanimous vote. Given the federal agencies' desire to maintain their roles in the various regions, the desire of the agency clienteles to maintain their subsidies and the tendency of each state to view issues from only their point of view, little could be done to effect real river basin planning.

A more practical approach to overcoming jurisdictional externalities would be to extend water markets to encompass larger parts of or entire river basins. At the intrastate level, better informational systems regarding desires to buy and sell would serve better to allocate water to its highest valued uses. Vaux and Howitts' observations on the discrepancies in marginal values of water in different parts of the State of California (1984) are indicative of the scope for improving intrastate allocations. At the interstate level, there are significant opportunities for efficient reallocations. Booker and Young have quantified these opportunities for the Colorado River. The State of California proposed in 1991 the establishment of an " interstate water bank" on the Colorado River

that would organize interstate water leases for one year at a time. The trades were to have taken place through each states' water agency so that broader public interest issues would be taken into account. While the proposal was quickly vetoed by several states, interest in interstate water markets has continued. The Bureau of Reclamation has assisted the three Lower Basin states in arriving at an exchange and storage agreement that has many of the features of a market (ref?).

The effectiveness of extending the geographical scope of water markets depends in part on broadening the concept of "beneficial use". Since many of the values that are currently ignored in water allocation and reallocation are instream values, extending a water market to encompass downstream areas where many instream values are generated would accomplish little if instream values were not recognized as "beneficial". Since individual water users would not be able to acquire sufficient water rights to offset decreases in the dilution of salts, public entities (local, county, state or special district) should be allowed to hold water rights for instream purposes. An example of instream protection is found in Boulder, Colorado's recent dedication of $12 million worth of water rights to protect late season flows in Boulder Creek. Under Colorado law, this can be accomplished only by turning the rights over to a state agency (Water Conservation Board) which is then charged with enforcement of the instream rights. The process should be made simpler and more direct.

Thus, the geographical extension of water markets, combined with an extension of "beneficial use" to encompass instream uses and authorization of governmental units to buy and hold water rights for instream purposes, would overcome many of the current inefficiencies stemming from jurisdictional incongruities and inadequacies of state water law.

B. Compensating Basins-of -Origin for the Real Costs of Adjustment.

It was argued earlier that some real efficiency costs are among the secondary impacts imposed on areas from which large quantities of water are transferred. These costs are imposed on activities that are "backward linked" (supplying inputs) or "forward linked" (processing outputs) to agriculture. Insofar as these costs are not taken into account by buyers and sellers in water markets, there is the possibility of excessive transfers. Communities absorb these costs, often with great hardship.

It would be appropriate, therefore, from both efficiency and equity viewpoints that buyers and/or sellers make compensatory payments to public authorities of the area of origin (MacDonnell and Howe, 1986; MacDonnell et al, 1990). This compensation should be in a form that will meet the priority needs of the area of origin. An example of *inefficient* compensation to areas or origin is found in the Colorado Water Conservancy District Act of 1937 which requires any project exporting water from the Colorado River Basin to another part of Colorado to provide "compensatory storage" within the Colorado Basin-whether it is needed or not. The compensatory storage provided by the Colorado-

Big Thompson Project (exporting Colorado River headwater supplies to northeastern Colorado) took the form of Green Mountain Reservoir on a tributary of the Colorado that stood unused (for purposes of supply augmentation) for 50 years.

The suddenness of some transfers leaves little time for adjustment in the exporting region and increases the severity of the impacts. Thus a second way of mitigating the negative effects on the area of origin would be *to require a spreading of the withdrawals over a period of years*. This is currently required by Colorado water courts for purposes of revegetating lands to be dried up by water transfers. This can usually be done with little damage to the buyer of the water, since cities usually buy in advance of actual need.

Finally, the negative impacts of large water transfers could be mitigated by allowing the lands from which water rights are to be transferred to acquire other, more junior rights to keep the land in production. In Water Division 3 in Colorado, the water court has required that land from which water has been sold "shall never engage in activities that involve the withdrawal of water from the Arkansas River". i.e. the land is to be dried up forever. The reason given by Division 3 was that it facilitated the monitoring of water use by making it clear that the land was not surreptitiously diverting water after selling its rights. Since the purpose of water administration is to maximize the effective use of water and not to minimize the work to be done by the water master, this requirement is counter-productive. Agricultural lands close to the rivers was the first to be cultivated, with irrigation water coming from the adjacent river. The water rights were therefore quite senior. Naturally, these are the rights sought by urban and industrial buyers. From the view-point of efficient water use and from the viewpoint of the community, it makes perfect sense to let the farmer sell the senior rights, then buying junior rights to maintain farming operations. Depending on the reliability of the rights purchased, the cropping pattern might have to be changed but can still be profitable, given the lower investment in water rights. The secondary impacts on the community will be much less severe than with the permanent drying up of the land.

C. Protecting Social and Cultural Values.

The compensatory steps discussed above will, naturally, help to protect the social and cultural values of areas-of-origin of transfers. Additional issues are involved when the communities are low income, culturally differentiated communities like the old Hispanic communities of the U.S. Southwest that center their culture on water and its symbolism. In some cases, the problem is to protect existing supplies and in others to acquire supplies to serve community needs. The latter situation is illustrated by the "Winters Doctrine" that assigns water rights to Tribal lands with a priority date of that of the establishment of the Reservation. Other groups don't have this protection.

The main protective step in such situations is to vest the water rights in the community and not in individuals, so that community-wide decisions will be required to sell water. The community-wide tradeoffs between funds raised through water sales and

the continuation of traditional activities can then be addressed fully. If individuals are permitted to sell water, the resulting checkerboard pattern of rights ownership can be culturally disruptive, hydrologically debilitating, and administratively complex.

V. Possible Problems of Water Market Manipulation.

The possibility of monopolization of water supplies through water markets cannot be ruled out. In some settings, especially in early stages of the development of water supplies where unappropriated water exists alongside rapid economic development, undue control of water supplies by a small number of parties can occur. An example is found in Chile where the water system was changed in 19XX from one of state ownership to private ownership of natural water supplies (Reference here the journal paper on the Chilean situation.). At the time the law changed, the national power company applied for and was granted rights to a majority flow in several major central Chilean rivers. This monopolization of these supplies allowed the power company to optimize the regulation of flows for power purposes, but , in doing so, denied use to important parts of the agricultural sector. In addition, as urban and industrial needs grow, the power company controls the only reasonable supply. It is, therefore, charging very high prices to transfer water to M&I uses. A major reason for these undue claims on water is that there is no "beneficial use doctrine" in Chile. Various reforms are now under consideration by the national legislature.

Monopolization must not be confused with *speculation*-a term that carries bad connotations for many people. Speculation is the financial act of accepting a risky situation in which losses may be incurred but in which profits are sufficiently likely to make the situation attractive to the *speculator*. The most frequently cited case is in the grain futures markets, where grain speculators take futures contract positions that are the opposite of the futures positions taken by parties wanting to reduce price risk-usually farmers who want to make their profits on farming operations, not on gambling on grain prices. Such parties are known as *hedgers*. On average, the hedgers give up to speculators potential profits due to favorable price changes in order to escape the risk of adverse price movements. The function of speculation, therefore, is to allow parties to shift risk to those parties who are in a position to accept it in return for an average profit over time.

In water resources, the speculator-hedger distinction is not as clear, but the speculator still is a party that controls water in one form or another (water rights, ditch company shares, etc.) with the intention of making a profit on the later sale of the water. Insofar as the speculator can "hold" the water and insofar as the speculator's ability to forecast future conditions is better than that of the average water market participant,

speculation can prevent water from being committed to less productive uses. “Speculative uses” presumably are ruled out by the “beneficial use doctrine”, but water courts and water organizations have been reluctant to declare various applications “non-beneficial”. The typical speculation in water consists of buying a ranch or farm, continuing the regular agricultural production until water prices become high enough that profits can be made by separating the water from the land and selling both. Even the average farmer in today’s setting is a speculator holding the expectation that water prices will continue to rise.

One form of speculation is specifically accepted in most western states, namely allowing cities to establish “conditional rights” that need not be used now in anticipation of future growth of water demands. Such rights are often not developed for decades, there being a requirement only to show “due diligence” toward the ultimate development and use of the water. The “due diligence requirement usually consists of a low level of planning or physical activity. The City of Denver holds conditional rights to several hundred thousand acre feet per year (check this) in the Blue and Colorado River Basins. While such rights provide the owning cities assurance of future supplies, they create substantial uncertainty for other water rights owners who don’t have that option. Rights that are currently served all the time may find themselves much farther down the seniority ladder when the conditional rights are actually developed and used.

In sum, the monopolization of water markets is a possibility but is unlikely in highly developed markets having little unappropriated water. Small scale speculation occurs everywhere and really cannot and should not be prevented. A reasonable interpretation and enforcement of the beneficial use doctrine will be sufficient to avoid monopolization while not preventing useful small scale speculation.

VI. Conclusions.

An evaluation of alternative water allocation mechanisms, using a set of broadly accepted criteria, shows that water markets will play an increasing role in the allocation and reallocation of water. While markets perform the allocative role quite well within the framework of the private values of the buyer and seller, important public values are likely to be overlooked in the process. Thus public oversight of the water market process is needed .

Among the problems identified above are jurisdictional externalities that occur because political boundaries do not coincide with the watersheds to be managed. Then many “public good” types of services created by instream flows are omitted from

consideration. In addition, the "secondary impacts" of large-scale water transfers are partially constituted of real economic costs in the areas-of-origin. These, too, will be omitted from private consideration of water transfers. Social and cultural values in poor ethnic communities will not be registered in pure market transactions since the communities are too poor to participate in the market for water, and they are likely to be underrepresented in the political process.

Various ways of protecting these public values without unduly discouraging the market process have been set forth above.

1. To overcome jurisdictional externalities, extend the geographical scope of the market. The larger the market area, the greater will be the competition among possible users, including those who would protect instream values. Then market prices will more closely approximate true opportunity costs. Serious consideration needs to be given to interstate water markets.

2. If all types of values are to be represented in the market process, the concept of "beneficial use" must, in many cases, be broadened. In particular, instream values of all types must be acceptable, including not only recreation and environmental values but the use of flows for water quality purposes like dilution of dissolved solids. This is needed if the geographical extension of water markets is to be effective in reflecting full opportunity costs.

3. Allow public bodies to own water rights for the protection of "public values" that cannot be protected by individuals. This involves facilitating the purchase and holding of water rights by public bodies for public purposes, including instream flow purposes.

4. To reflect the full costs of water transfers via markets and to be equitable toward the areas-of-origin, the following steps should be taken:
    a. require monetary compensation to the governmental unit of general jurisdiction in the area-of-origin. This compensation would approximate the present value of real costs indirectly incurred in local economic activities that are linked to the activity from which the water is being sold, plus public sector costs involved in adjusting to the changes in economic activity , e.g. compensating for the loss of tax base. This will be particularly important when the water exports are from a depressed area where replacement activities are not likely. Since the calculation of these costs is difficult and subject to error, a standard payment per acre-foot is probably best.

    b. to ease the impact of large transfers on the area-of-origin, require the spreading over time of the actual movement of water, e.g. 20% of the total sold each year for five years. This is currently done for

purposes of revegetation of lands dried up by water transfers. The same can certainly be done for purposes of social and economic adjustment.

c. allow the re-watering of lands from which the water has been sold. Arguments for this were made in the text, but there is no economic reason for permanently drying up lands that can be adapted to alternative patterns of agriculture using more junior water rights.

5. To protect the cultural values of water use in poor communities, water rights should be vested in the community so that the full social importance of the water resource can be debated when water sales are proposed.

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